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ELECTRONIC WARFARE SYSTEMS

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DEVELOPMENT PROSPECTS OF AIRBORNE ELECTRONIC WARFARE SYSTEMS

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ABSTRACT: The article describes the most recent technological progress on airborne radar warning dispenser-type jammers and reconnaissance receiver pods, jammer pods, as well as navigation and communication pods. Moreover, the article describes applications in data processing and target discrimination to electronic warfare expert systems and neural net systems. Technical developments are detailed for two versions of antiradar hard casualty-producing weapons: antiradiation missiles and antiradar drones.

Key Words: airborne electronic countermeasure equipment, electronic warfare, antiradiation missiles, drones.

Introduction

The breakout of the Gulf War on January 16, 1991 enabled the world to sufficiently realize the important functions of

electronic warfare. As an example, when 20 U.S. F-16s flew over Kuwait on January 17, the planes were attacked by 80 Soviet-built surface-to-air missiles. The American pilots immediately switched on their model AN/ALQ-119 self-defense jammers, by scattering large numbers of chaff. As a result, not a single one of the American craft was struck. This case can illustrate that the airborne electronic warfare system is a vital item of fighting equipment in preserving pilot safety and eliminating enemy personnel. In the opinion of military circles, if no airborne electronic warfare equipment is installed on a bomber, its survivability is only 25%. With such equipment, the survivability can be raised to more than 95%. No wonder, American pilots insist on having all airborne electronic warfare equipment before taking off for air combat. There is a Nilisi [transliteration] aircraft proving ground of 15,540km2 in southern Nevada maintained by the U.S. Air Force mainly to train pilot fighting capability in coping with electronic countermeasure threats. There are more than 500 plants and companies with more than 300,000 scientific and technical personnel in the United States engaged in development and research of electronic warfare. The United Kingdom, France, Russia, Germany, and Israel, among other countries, also spent large numbers of manpower and resources to develop various novel and effective electronic warfare equipment. Later, from the nineties to early next century, what will be the direction of development for airborne electronic warfare systems? The article

makes a generalized prospect on the development of such advanced technologies of airborne reconnaissance receiving, high-level signal-sorting and data processing, launch jamming, command control, antiradiation missiles, and mobile decoys.

I. Electronic Reconnaissance

1.1. Airborne radar warning receivers

When an aircraft is illuminated by an enemy radar wave beam, the aircraft radar warning receiver immediately displays on a screen with color pictures, radar signal data and letters, modulation modes, and threat levels. In October 1994, the Loral Corporation in the United States will provide advanced ALR-56M radar warning receivers to U.S. Air Force F-16s. This is a wideband receiver, capable of highly precisely displaying the various important parameters and information of ground radar according to the order of threat levels and velocity.

1.2. Airborne reconnaissance and receiving pod

Developed by the Thomson-CSF Corporation in France, the ASTAC tactical electronic reconnaissance and receiving pod, is 4m long, 0.4m in diameter, and weighs about 400kg. These pods can be suspended beneath modern planes, such as the Mirage-2000. The frequency range of reconnaissance and reception is between 0.5 and 40GHz. The accuracy in positioning threat sources is better than 1o. In the pod, there is a wideband frequency scanning receiver for rapid acquisition of various threat radiation source

signals. Another narrow-band superheterodyne receiver is used for precise surveillance. In other words, an analysis of the frequency spectrum of the acquired radio frequency signals is made, capable of automatically analyzing and processing signals from scores of radar sets each second.

The adoption of these pods is a conventional structure of the airborne electronic warfare equipment. The principle advantage are as follows: the equipment is independent, capable of adjustment and testing of an individual device. The airborne structure is not damaged as such pod can be easily suspended under a plane. This is more advantageous for small-size combat aircraft because its small size just fits in the small internal space of a fighter.

III. Electronic Jamming

2.1. Dispenser-type jammers

Overseas, in the eighties, there were models of dispenser-type jammers. For example, in the mid-eighties, Marconi Corporation in the United Kingdom, has available high-performance suppression-type dispenser jammers. By using parachutes, multiple jammers are dropped over enemy radar, or are landed near radar stations. Such jammers can operate continuously from 4 to 8h, or even longer, capable of intensively suppressing and jamming enemy radar, thus ensuring our side's superiority in electronic warfare during combat.

Beginning in 1994, model GEN-X jammers have been available

from Texas Instruments, in the United States. The device is an ultraminiature deception-type dispenser jammer, about 170mm long, 50mm in diameter, and 0.45kg in weight. Before being dispensed, the device, based on the waveform features and modulation of the radar signals received, after making the most effective deception modulation of the radar signals with the dispenser jammers in transmitting to enemy radar, so that the radar tracks a "target" in a false direction after receiving such deception signals. Or, the enemy radars are unable to demodulate the echo signals.

2.2. Electronic jammer pod

In the most recent decade, the electronic jammer pods have undergone rapid developments. This is a major weapon in "soft killing" of enemy radar by airborne electronic warfare systems. At present, the advanced high-performance jammer pods are represented by the Apollo pod delivered to the Air Force in 1992 by the Marconi Corporation in the United Kingdom. The distribution type microprocessor controls the operation of the Apollo pod, which can coordinate with other reconnaissance and receiving pods. In the pod, there is attached with flares and chaff dispensers, capable of simultaneously applying powered and unpowered electronic jammers and infrared jammers. The jammers are driven by Ada-language software, capable of generating various suppression jamming and deception jamming in order to effectively cope with various continuous-wave or pulsed radars. Within several microseconds, the jammer can quickly send out

jamming signals. Once high-power random wave jamming enters a radar receiver, the jamming can swamp the echo signals of the radar, so that no other counterjamming measures will be effective.

III. Airborne Navigation and Communication Pods

The joint tactical information distribution system (JTIDS) is a standard electronic countercountermeasure transmission and navigation guidance system for the United States and NATO countries since the nineties. By using a series of couunter-jamming technical measures, such as jump frequencies, expanded frequencies, encryption, and false-correction, the enemy destructive jamming can be overcome.

All JTIDS signals are shown on a fluorescence screen, capable of providing real-time command signals for pilots in an instant. When making close-range air support flights, pilots can receive such data as turn point, target discrimination, target position, and position of bomb drop point by aiming at the target. In addition, threats and situations of enemy and friendly aircraft from all directions can be provided. Additionally, the system can provide accurate meteorological signals.

When pilots are asked the following question: Are you very much helped in accomplishing your flight mission after being provided with JTIDS? All pilots who have experienced the JTIDS will answer, Yes.

There are two major points with JTIDS: (1) there is a very low probability of mistakenly deciding on the information, and (2) it is easy to carry out the navigation guidance, communication, and target acquisition.

Information of flight conditions of enemy and friendly aircraft broadcast by E-3A early-warning aircraft and ground center command posts is received by fighters. In the next several years, more than 6000 tactical craft of the United States will have the JTIDS installed. At present, the system has been installed in some F-15s and F-16s. Since they are the most advantageous with the pod arrangement, the JTIDS equipment also employed the pod form of installation.

IV. Electronic Warfare Expert Systems

A good electronic warfare expert system can enable the system to have a certain amount of intelligence, therefore being capable of adapting to environmental changes in electronic warfare. The functions of the system are as follows:

(1) Determination of the type of threat source and the threat level; (2) determination of effective jamming modes in respect to various threat sources; (3) distribution of jamming resources for rational management of jamming power; and (4) determination of jamming effectiveness.

First, the electronic warfare expert system is used in a dedicated large electronic warfare aircraft. With further miniaturization, such system can be used in tactical aircraft.

To coordinate with the information processing and target discrimination of the electronic warfare expert system, the science of neural nets with the human brain as the model explores applications to electronic warfare in earnest. Thus, distinctions should be clarified between the human brain and present-day computers in order to further simulate human brain functioning. The main distinctions between the human brain and computer are as follows:

(1) The human brain has high degree of parallel operation.

Computers have series operational capability built on the von Neumann model of serial processing. Computer operations should be based on predesigned complete sets of serial algorithms. However, as to actual problems of electronic warfare situations, problems are difficult to solve when relying only on serial algorithms.

(2) The human brain has a high degree of nonlinear overall functioning.

Each neuron receives large amounts of information inputted from other neurons, generating output signals with nonlinear input/output relationships. The neural net follows the overall operational principle, this is the overall performance, but not the iterative addition in the local performance. At present, computers find it difficult to function in an overall manner.

(3) The human brain has very good fault tolerance as well as associative and memory capability. People can find out in the dark somebody they know from among a group based on hearing, or

they can recognize an acquaintance on a city street after three decades of separation. It is still difficult to achieve this capability in present-day computers.

(4) The human brain has the capability of self-adaptation and self-learning.

People can learn by reading books. When it comes to a computer, at the latest it is not able to do so, even if given a book to allow it to learn from it. A highly intelligent computer used in actual combat still requires years of exploring new technological means before successful development.

V. Antiradar Hard Kill Equipment

5.1. Antiradiation missiles.

Antiradiation missiles are also called antiradar missiles. As early as 1965, in the Vietnam War, the U.S. Army applied the first antiradiation missile, Lark [baisheniao in transliteration], to inflict serious damage to ground radar for air defense in North Vietnam. In 1991, in the Gulf War, U.S. troops fired a total of 2000 third-generation antiradiation missiles, HARM, causing great losses to Iraqi radar networks. A HARM missile is 4.17m long, 0.25m in diameter, and 337 kg in weight. Its maximum range is greater than or equal to 40km and its maximum flight velocity is Mach 3 to 4. The missile can automatically acquire and lock on the frequency and orientation of ground radars, capable of attacking radar stations operating between the frequency band 0.8 and 20GHz. The guidance method is

passive homing and fast-response inertial guidance. Upon approaching a radar station, a laser fires off the fuze to trigger the warhead, by using more than 10,000 tungsten-alloy fragments for killing and maiming personnel with the destruction of the radar and its antenna. During low-altitude flights, the HARM missile can also be fired. As the radar scattering cross-section of the HARM missile is less than 0.1m2, it is hard to detect. Its engine is smokeless, so that it is difficult to see. HARM missiles are hard-kill weapons for radar operators. Its development trend is as follows: by increasing the range and flight velocity, as well as enhancing the antiradar decoy deception capability, with enhancement of receiver sensitivity and broadening of signal activities, to further enhance the hit accuracy, warhead power, as well as cost reductions, among other factors.

5.2. Antiradar drones

At present, drones have been developed and built in more than 20 different countries. There are more than 100 drone models, with widespread applications. In foreign military circles, air-launched antiradar drones have been deployed with troop units for reconnaissance hard kill of enemy radar.

The antiradar drone remains in the air for long periods of time, capable of automatically making reconnaissance of the enemy radars. After fast positioning, the kamikaze-type attack can be executed, as in the way of world War II Japan. Therefore, the

function of destroying enemy radar and protection of our craft can be performed. This type of drone is low in cost and therefore it is suitable for mass-production for troop deployment. For example, in 1995, 4000 drones will be built by Dornier Corporation in Germany. Built by Northrup in the United States, the model AGM-136A drone (Mohawk) can be launched from B-52 bombers or A-6E attack craft. Thirty such antiradar drones can be put in the rotary bomb compartment of a B-52 bomber. The AGM-136A is 2.5m long and 0.69m in diameter, with a 90km range and a payload of 120kg. The drone has the wave absorption concealment properties, so it is hard to spot. These drones can attack radars operating in the 2 to 35GHz waveband, with air staying time of more than 2h. There is a 57kg tactical surveillance radar on the drone; the radar can automatically search for targets from the ground background of random emissions.

An antiradar drone consists of an automatic piloting instrument, a computer, a guidance head, a power supply, a warhead compartment, and a fuselage. Compared with the antiradiation missile, the drone has capabilities of long range, high warhead power, capable of reconnaissance relaying, and suppression of radar networks over a wide area. It has the following disadvantages: low flight velocity; inability to cope with a sudden shutdown of enemy radar because of the absence of a fast-response inertial guidance equipment. Such drones should be placed in the bomb bays of large-model aircraft, since they

cannot be suspended under the wings of small combat craft. However, such drones are also a kind of hard-kill weapon, frightening enemy radar operators.

VI. Conclusions

Electronic combat between enemy and friends is an endless struggle. Airborne electronic warfare systems are also being continuously upgraded and developed. The various research accomplishments of new technologies will continuously renew the electronic warfare equipment to be applied in newer aircraft. For example, the future F-22 fighter of the U.S. Air Force will be equipped with comprehensive electronic warfare system, such as radar warning, missile attack warning, electronic reconnaissance and positioning, threat source discrimination, rapid and effective firing of multiple jammers, and antiradiation missiles. Backwardness is to come under attack. Therefore, we should exert endless efforts in upgrading the combat performance of airborne electronic warfare systems.

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